CHAPTER II.7: COST OF COLORECTAL CANCER

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CHAPTER II.7: COST OF COLORECTAL CANCER

This chapter contains a discussion of the methods used to estimate and the results of estimating the direct medical costs incurred by surviving colorectal cancer patients.[1] It does not include information on elements such as indirect medical costs, pain and suffering, lost time of unpaid caregivers, etc. The reader is referred to Chapter I.1 for a discussion of the cost estimation methods and cost elements that are relevant to all benefits estimates. In addition, Chapter II.1 contains information regarding cancer causality, a list of known and suspected carcinogens, and information on cancer cost estimation.

The costs presented in this chapter were current in the year the chapter was written. They can be updated using inflation factors accessible by clicking on the sidebar at left.

Link to Chapter I.1 and II.1
Link to inflation factors

Survival data from the National Cancer Institute (NCI, 1998) and cost data from Baker et al (1989) that are used in this chapter do not provide quantitative information for different types of colorectal cancer. Consequently, this chapter contains an evaluation of all types in aggregate. In addition, most risk assessments used in evaluating benefits do not specify the type of colorectal cancer.

II.7.A. Background

II.7.A.1. Description

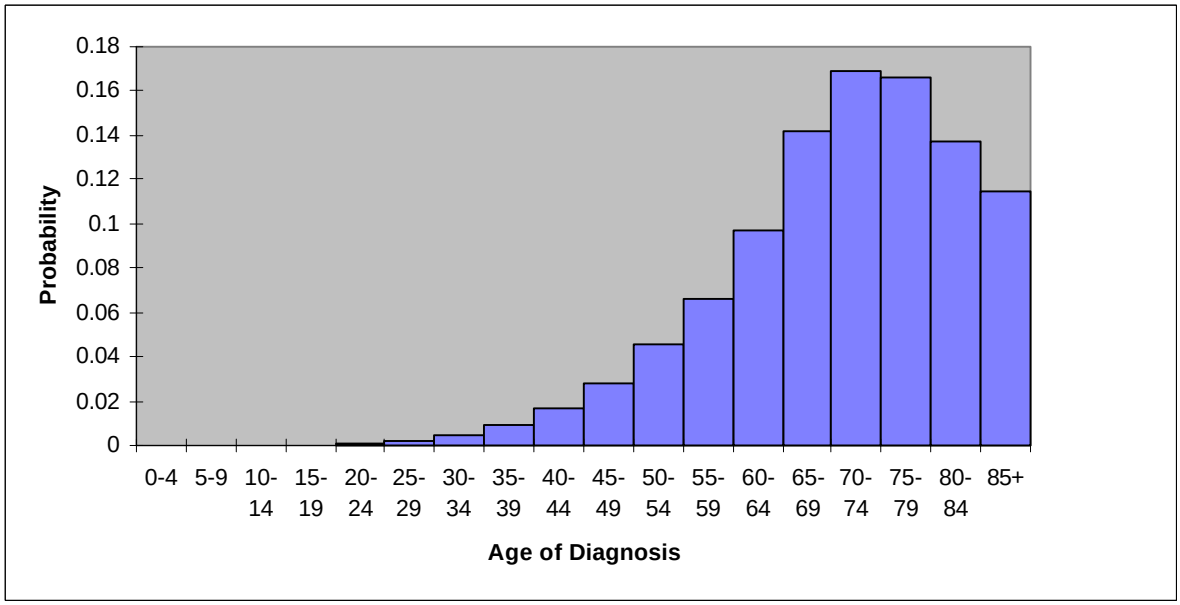
Colorectal cancers are malignancies of the colon or rectum. They are most often adenocarcinomas that are thought to develop through genetic alterations in the cells. Colorectal cancers can be differentiated, based on the site of the tumor(s). As noted above, however, they are considered as a single cancer type for this cost analysis.

Most cases of colorectal cancer occur among the elderly, which is typical of cancer. The average age at diagnosis is 70.4 years. Less than two percent of colorectal cancers are diagnosed before the age of 40, and 42 percent are diagnosed over the age of 75 (NCI, 1998). The age distribution at diagnosis of colorectal cancer is shown in Figure II.7-1. The

[1] Survivors are those who do not die of this specific disease. This chapter was prepared in response to EPA's specific requirement for a proposed rule. Because they were using the value of a statistical life (VSL) for those who die of the disease, they required only cost data for disease survivors. Sources provided in the chapter can be used to calculate medical costs for nonsurvivors, if required.

steep incline in the probability of diagnosis is clear in this diagram, with a peak around 70 years of age. The data used to generate Figure II.7-1 are shown in Table II.7-1. The cumulative percents of colorectal cancer at various ages were calculated using the population-weighted distribution of occurrence. These percents are also shown in Table II.7-1. Approximately 60 percent of all colorectal cancer cases are diagnosed in the relatively small age interval of 70 to 85 years.

Figure II.7-1



The age-specific incidence data were used in Section II.7.B medical cost calculations. Data on incidence and age at diagnosis were obtained from NCI's Surveillance, Epidemiology, and End Results (SEER) reports and tables, obtained on line through the NCI web site at: http://www-seer.ims.nci.nih.gov in 1998.

Table II.7-1. Age-specific Incidence of Colorectal Cancer			
Age Group	**Age-specific Rate of Diagnosis Per 100,000**	**Percent of All Colorectal Cancer Occurring in Age Group**	**Cumulative Percent of Colorectal Cancer**
0 - 14	0.1	0.0	0.0
15 - 34	5.5	0.8	0.8
35 - 39	6.4	1.0	1.8
40 - 44	12.7	1.7	3.5
45 - 49	24.7	2.8	6.3
50 - 54	49.9	4.5	10.8
55 - 59	88.4	6.6	17.5
60 - 64	140.3	9.7	27.2
65 - 69	206.4	14.1	41.3
70 - 74	281.5	16.9	58.3
75 - 79	367.8	16.6	74.9
80 - 84	457.5	13.7	88.6
85+	473.1	11.4	100.0
Based on NCI, 1998			

II.7.A.2. Concurrent Effects

As with all cancers, colorectal cancer may spread to other organs. Colorectal cancer often spreads to distant sites, involving regional lymph nodes, or to the liver or lung (Abeloff et al., 1995). In addition, treatment of cancer, which usually includes chemotherapy, radiation, and surgery, has numerous adverse side effects and may in itself lead to death. Radiation treatments of cancer have led to increased risks of other types of cancer, sterility, etc. Surgery may cause long-term changes in health status that may also lead to death. These effects are associated with additional medical costs not considered in this chapter.

The material herein was specifically developed for the U.S. EPA for use in the analysis of a particular Rule, and does not include information regarding additional medical costs incurred from concurrent effects of colorectal cancer or its treatment.

II.7.A.3. Causality & Special Susceptibilities

Dietary, environmental, and heriditary factors are important in colorectal cancer causality (Abeloff et al., 1995). Table II.1-1 in Chapter II.1 contains a list of chemicals known to cause or are suspected of causing cancer (as reported in the EPA databases IRIS, HEAST, and HSDB). Most chemicals in the table were carcinogenic in animal studies. These studies do not provide organ-specific data because it is not generally assumed that cancer induction will necessarily occur at the same site in humans as in animals. Consequently, the chemicals listed in Table II.1-1

may cause colorectal cancer and/or other types of cancer. Evaluation of the likelihood of this occurrence would require additional risk assessment research.

Link to Table II.1-1

Epidemiologic studies worldwide have documented a direct correlation between colorectal cancer mortality and per capita consumption of calories, meat protein, and dietary fat and oil (Mayer, 1998). Other risk factors include hereditary syndromes (as many as 25 percent of colorectal cancer patients have a family history of the disease), and inflammatory bowel disease (colorectal cancer risk is relatively small among this population during the first ten years of the disease, but it increases at a rate of approximately 0.5-1 percent per year) (Mayer, 1998). Various syndromes affecting the intestine are linked to a much higher risk of colorectal cancer, and both primary and secondary mutations are found in about 15 percent of cases. In addition to genetic alterations, abnormal DNA methylation is an important factor in colorectal cancer. There has been, and continues to be, intensive study of the genetic aspects of this disease (Abeloff et al., 1995).

Colorectal cancer generally affects the over-50-year-old population. Most colorectal cancers, regardless of etiology, are believed to arise from adenomatous polyps, which have been found in the colons of approximately 30 percent of middle-aged or elderly people. Less than one percent of these polyps, however, ever become malignant (Mayer, 1998) Other risk factors include prior history of breast, ovarian, endometrial, genital, colon, or bladder cancer.

NCI provides age-, sex-, and race-specific data regarding diagnosis of colorectal cancer from 1990 to 1994, which may be used to evaluate susceptibilities among population subgroups. The data must be used with care, however, because diagnostic rates indicate occurrence only, and may or may not indicate differences in susceptibility. See Chapter I.1 for a more detailed discussion of susceptibilities.

Link to Chapter I.1

NCI colorectal cancer diagnosis and mortality data show higher diagnosis and death rates among men than women. From the 1973 to 1994 time period, males generally had a 50 percent higher mortality rate than females. Over the time period of 1978-1994, black women consistently showed higher incidence rates than white women. The percent change from 1973 to 1994 were +14 percent and -11 percent, respectively.

The rate of diagnosis among black males from 1973-1994 was higher than that in the white male. Over the period 1973 to 1994, incidence rates among black men increased 34 percent, while it dropped five percent in

white men. A similar trend was also observed of mortality rates over that same time period.

II.7.A.4. Treatments and Services

Colorectal cancer is usually treated with surgery, chemotherapy, and/or radiation, depending on the type of colorectal cancer, the stage of cancer at diagnosis, patient health, and other factors. The treatment is defined more precisely by histologic type and specific location of the cancer. In this analysis, all histologic types and sub-sites are considered together. Most surgery involved en bloc resection, which entails removing large sections of the intestinal tract. This procedure may be modified if cancer has not spread to regional lymph nodes (Abeloff et al., 1995). Treatment for this type of cancer often requires permanent lifestyle changes due to the nature of the surgical intervention required.

Treatment is carried out in phases including initial diagnosis, initial treatment, follow-up and maintenance treatment, and, for those who do not survive, terminal treatment and palliative care. Although there are some components of each treatment that are unique to each phase, most medical activities and services may occur more than once over the course of the disease from diagnosis to death or cure. For example, X-rays may be used in diagnosis, to provide ongoing status updates, to assist in determining initial and subsequent surgical and other treatment interventions, etc.

Initial diagnostic activities may include an evaluation of signs and symptoms, X-rays and other types of imaging, laboratory tests, and other procedures. Staging of the disease occurs during this phase and is critical to determination of subsequent medical actions (Feld et al., 1995). Surgery is usually performed, as well as radiation and/or chemotherapy. In some patients, cancer has spread to other organs requiring additional treatment strategies. Colorectal cancer is fatal in approximatley 50 percent of patients. Consequently, most patients receive terminal care that may include a variety of medical services, long-term care in a nursing facility, palliative care, family counseling, etc.

II.7.A.5. Prognosis

Cancer of the large bowel is the second highest cause of cancer death in the U.S. Although approximately 70-80 percent of all patients survive colorectal cancer for three years following diagnosis (NCI, 1998),

approximately 47 percent of patients die of colorectal cancer within ten years of diagnosis (53 percent survive).[2] This value is used as a reasonable approximation of the lifetime mortality rate in later sections of this chapter.

Factors such as tumor size and location, histology, involvement of nodes, and the spread of cancer to other tissues affect outcome. As with other cancers, the prognosis of colorectal cancer is determined partially by the occurrence of cancer at other sites. When it has metasticized, the survival rate is poorer. As noted above, colorectal cancer generally spreads to distant sites, involving regional lymph nodes or the liver. The latter is reportedly the initial site of distant cancer spread in 33 percent of recurring colorectal cancer patients, and involved in over 66 percent of such patients at their time of death. In fact, colorectal cancer rarely disseminates to the lungs, bone, or brain without hepatic involvement first. The median survival duration for colorectal cancer-associated liver metastases ranges from 6-9 months to 24-30 months (Mayer, 1998).

The prognosis for this cancer has improved in recent decades. An estimated six to eight percent increase in survival over the past two decades has been reported (Abeloff et al., 1995). The change has been attributed to earlier detection and a decrease in treatment-related mortality. The mortality rates among African-American patients are typically higher than within other racial groups.

II.7.B. Costs of Treatment and Services

II.7.B.1. Methodology

II.7.B.1.1 Overview

As noted above, this chapter examines the direct medical cost for the "average" colorectal cancer survivor and does not include nonsurvivors of colorectal cancer.

II.7.B.1.2 Medical Cost Data

II.7.B.1.2.1 Sources

Medical cost data would ideally be obtained on current medical expenditures. Although data files are maintained by public and private sector sources, they are not readily available. In addition, it is necessary to evaluate very large databases of charges from a variety of sources to obtain

[2] The SEER data reports were accessed online to obtain information regarding mortality and survival probabilities (RSRs) (NCI, 1998). The RSR is the number of observed survivors among these patients, divided by the number of "expected" survivors among persons with the same age and gender in the general population (observed/expected). The RSR takes into account that there are competing causes of death that increase with age. Methods used to convert the NCI statistics to survival probabilities are described in detail in Chapter II.2.
Link to Chapter II.2

reliable cost estimates. That method was not practical for the development of this chapter. A data search was conducted to locate information in the medical economics literature regarding medical costs associated with colorectal cancer. In addition to a literature search, most federal agencies dealing with cancer, disabilities, medical costs and their management, and related issues were contacted for information; the various federal databases were discussed with senior staff at these agencies. Very recent cost data were not located.[3] Current (1994) cancer data were obtained regarding incidence and survival (as reported in Section II.7.A, above), and were used with cost data from the 1980s, described below.

The cost estimates presented in this section are based primarily on the work of Baker et al. (1989) and Hartunian et al. (1981) and on two sources of statistical data: the National Cancer Institute (1998) and Vital Statistics of the United States, 1995, Preprint of Volume II, Mortality, Part A Section 6 Life Tables (NCHS, 1998). These data were evaluated and cost and time elements were used to calculate lifetime estimates of the direct medical costs due to colorectal cancer. Based on a 1998 review of the literature, carried out for the development of this chapter, there do not appear to be new treatment methods for lung cancer that alter either the medical costs or the survival rates for most patients substantially. Consequently, the cost estimates presented in this chapter may be considered appropriate under most circumstances (e.g., regional costs may vary).

II.7.B.1.2.2 Baker et al.'s Cost Estimation Method

Baker et al. (1989) used the Continuous Medicare History Sample File (CMHSF) to estimate the per-patient average lifetime medical cost of treating lung cancer based on data files from 1974 to 1981. They chose CMHSF because:

1) it is a nationally representative sample of the Medicare population (five percent), covering more than 1.6 million patients;
2) it is longitudinal, dating from 1974 to 1981; and
3) it captures the majority of medical expenses for each beneficiary.

Five Medicare files are included in the CMHSF, which cover:

1) inpatient hospital stays,
2) skilled nursing facility stays,
3) home health agency charges,

[3]Studies were located that used more recent cost data than were used in this analysis. The studies were not used due to serious limitations (e.g., data were incomplete). The studies are reported in the "Other Studies" section at the end of Section II.7.B.

4) physicians' services, and
5) outpatient and other medical services.[4]

Costs that were not included are outpatient prescription medications and nursing home care below the skilled level.

Because CMHSF provides no indication of initial diagnosis, Baker et al. assumed that disease onset occurred when a diagnosis of colorectal cancer was listed on a hospitalization record following a minimum of one year without a colorectal cancer diagnosis. This assumption is reasonable due to the high frequency of hospitalization associated with the disease (i.e., individuals diagnosed with colorectal cancer would be hospitalized). Only patients with an initial diagnosis during the years covered by the database (1974-1981) were included.

Costs associated with colorectal cancer were assigned to three post-diagnostic time periods:

- initial treatment, during the first three months following diagnosis;
- maintenance care, between initial and terminal treatment; and
- terminal treatment, during the final six months prior to death.

As noted in Chapter I.1, the amount paid for service may differ from the actual medical costs because many insurers and federal programs either 1) pay only a portion of total costs or 2) pay more than actual costs to underwrite the care providers' losses due to underpayment from other sources. Baker et al. used provider charges, rather than Medicare reimbursements (which represent only a portion of most total charges), thus providing a more accurate cost estimate.
To improve the accuracy of the cost estimates, Baker et al. included cost data on coinsurance, deductibles, and other cost components. They made four adjustments to the cost estimates calculated from the CMHSF. First, charges were added for skilled nursing facilities (SNFs) not covered by Medicare by multiplying the "length of stay" at an SNF (computed from admission and discharge dates) by the average daily SNF charge. Second, the annual Medicare Part B deductible of $60 was added to the reimbursed charges in the database. Third, since Medicare pays only 80 percent of physicians' charges, Baker et al. scaled these reimbursements to 100 percent of physicians' charges to better reflect social costs. Finally, they inflated all dollar values to 1984 dollars using the Medical Care component of the Consumer Price Index.

[4] See Baker et al. (1989 and 1991) for further details. Baker et al. (1991) contains additional descriptive data regarding the database and methods used for the cost analysis; however, it does not contain cost data for lung cancer.

II.7.B.1.2.3 Cost Estimates by Treatment Period

Medical costs associated with the initial, maintenance, and terminal cancer care treatment periods were itemized in Baker et al., 1989. These figures are reported as incremental costs in Table II.7-2, because the 1989 paper did not specifically report incremental costs or the costs of other medical services anticipated to occur while the patient was receiving cancer treatment (i.e., co-morbidity/background costs). To estimate the incremental costs, a co-morbidity cost of $2,988 per year (1984 dollars) from Baker et al. (1991) was used in this analysis.

The total cost for the initial three-month treatment period is reported in Table II.7-2, which includes the pro-rated co-morbidity cost for that three-month time period. Annual costs for the maintenance period are also shown and are further discussed in the "Lifetime Cost Estimates" section below (see II.7.B.1.3). Note that only the initial and maintenance costs are relevant to this analysis on colorectal cancer survivor population. Nonsurvivors, and hence terminal treatment costs, are not further addressed herein.

Using the Medical Care component of the Consumer Price Index (CPI-U), all costs were inflated to 1996 dollars for purposes of this handbook. For example, the 1984 annual co-morbidity cost of $2,988 would be equivalent to $6,394 in 1996 dollars, using the CPI adjustment multiplier factor of 2.14 for the period 1984 to 1996.

Table II.7-2. Average Per Patient Costs for the Treatment Periods for Colorectal Cancer (in 1996$)
Costs adjusted for inflation using the Medical Care component of the Consumer Price Index (CPI-U) 1996:1984 = 2.14 (Bureau of Labor Statistics)

Treatment Period	Incremental Cancer Treatment Cost
Initial (3 months)	$28,768
Maintenance (per year)	$8,295
Terminal (6 months)	$30,563

(Based on Baker et al., 1989, with co-morbidity charges from Baker et al., 1991.

II.7.B.1.3 Calculation of Lifetime Cost Estimates for the "Average" Colorectal Cancer Survivor

This section contains a discussion of the calculation of lifetime medical costs for the "average" colorectal cancer patient, identified in this analysis as an individual diagnosed at age 70.4 (the average age of colorectal cancer diagnosis from SEER, NCI 1998), with a life expectancy period of 13.8 years beyond that age (as determined by linear interpolation of NCHS 1998

data for the years 70 and 71). The approach described below was used to address specific EPA rulemaking requirements of the direct medical cost data. It therefore focuses specifically on the lifetime costs of colorectal cancer survivors over the life expectancy period from the average age of diagnosis. As in the previous chapters of this handbook, lifetime costs for nonsurvivors or for other compounding illnesses will not be presented.

The analysis assumes that death may occur only after the full life expectancy period from the average age of diagnosis has elapsed. All patients are therefore assumed to incur initial treatment costs during the first three-month period of the illness as defined by Baker et al. (1989). The costs incurred during the remaining months of the first year of illness are calculated by pro-rating the annual maintenance costs. For example, in the first year, the average colorectal cancer survivor incurs the costs of initial treatment ($28,768) over the first three months, and then incurs nine months' worth of maintenance care costs ($8,295 × 0.75 = $6,221) (see Table II.7-2). The total cost of colorectal cancer incurred during the first year to survivors is therefore $28,768 + $6,221 = $34,989, representing the intensive medical care treatment a patient would initially receive.

The expected medical costs for colorectal cancer patients during the first year post-diagnosis, then, is defined as:

> **Expected First-Year Cost: initial treatment costs over a three-month period + maintenance care costs for nine months**

Example: Expected first-year medical costs of a colorectal cancer patient diagnosed at age 70.4

As noted above, all colorectal cancer patients incur an initial treatment cost of $28,768. Those who survive through the year also incur maintenance care costs for the remaining three quarters of the year. Recall from above that the total first-year costs of those who survive the year were:

Initial treatment:	$28,768
Maintenance treatment:	$6,221 ($8,295 × 0.75)
Total First-Year Cost	$34,989

For each subsequent year post-diagnosis, medical costs consist entirely of annual maintenance care costs.

In this analysis, each patient would incur 13.8 years of maintenance costs, assumed to be a reasonable average period over which additional medical costs associated with colorectal cancer would also be incurred.

The expected medical costs for lung cancer patients during the *n*th year post-diagnosis, for *n*>1, then, is defined as:

<u>Expected *n*th Year (*n*>1) Cost:</u> maintenance care cost for the year, pro-rated as necessary.

Maintenance care costs are not assumed at full value in the last year (i.e., in the fourteenth year) of life expectancy. The treatment costs must be pro-rated based on how long a colorectal cancer survivor is anticipated to live in the final year of expected life. As previously discussed, linear interpolation of life expectancy data between the ages of 70 and 71 resulted in a forecast of 13.8 years, which means that only 80 percent of the annual maintenance costs ($8,295 × 0.80) will be incurred by the patient, or $6,636.

The expected lifetime or total cost to a colorectal cancer survivor is subsequently derived by summing all the expected medical costs over the entire period from diagnosis to death.

<u>Expected Lifetime Cost</u> = Expected first-year cost + the sum of the (discounted) expected subsequent-year costs

Using the initial treatment and maintenance costs listed in Table II.7-2, the mathematical equation for the expected lifetime medical costs incurred by the "average" colorectal cancer survivor over a 13.8-year period may be expressed as:

$$\$28{,}768 + (\$8{,}295 \times 0.75) + \sum_{y=2}^{13} \left[\left(\frac{\$8{,}295}{(1 + r)^{y-1}} \right) \right] + (\$8{,}295 \times 0.8)$$

Where: y = the year post-diagnosis, and
r = the discount rate.

The cost estimates for each year post-diagnosis and the estimate of expected undiscounted and discounted (at three, five, and seven percent) total costs for a fourteen- year period are shown in Table II.7-3 for the "average" colorectal cancer survivor diagnosed at age 70.4.

Table II.7-3. Expected Costs of Medical Services (in 1996$) for Surviving Colorectal Cancer Patients (Age of Onset = 70.4) Over a Life Expectancy Period of 13.8 Years

Years Post-Diagnosis (n)	Expected Medical Costs in the *n*th Year Post-Diagnosis (Undiscounted)[a]	Expected Medical Costs in the *n*th Year Post-Diagnosis (Discounted 3%)	Expected Medical Costs in the *n*th Year Post-Diagnosis (Discounted 5%)	Expected Medical Costs in the *n*th Year Post-Diagnosis (Discounted 7%)
1[b]	$34,989	$34,989	$34,989	$34,989
2	8,295	8,053	7,900	7,752
3	8,295	7,818	7,523	7,245
4	8,295	7,591	7,165	6,771
5	8,295	7,370	6,824	6,328
6	8,295	7,155	6,499	5,914
7	8,295	6,947	6,190	5,527
8	8,295	6,744	5,895	5,165
9	8,295	6,548	5,614	4,828
10	8,295	6,357	5,347	4,512
11	8,295	6,172	5,092	4,217
12	8,295	5,992	4,850	3,941
13	8,295	5,818	4,619	3,683
14[c]	6,636	4,519	3,519	2,754
Expected Total Cost[d]	$141,160	$122,072	$112,026	$103,624

a. The undiscounted initial and maintenance costs used in this table are from Table II.7-2, as adapted from Baker et al., 1989. *Link to Table II.7-2*
b. First-year costs include the charge for "initial" therapy ($28,768) and an adjusted maintenance cost pro-rated for the initial year (see text for discussion).
c. Final-year costs are pro-rated according to the average life expectancy (13.8 years) at the average age of diagnosis (70.4) (see text for discussion).
d. Sums may not equal reported totals due to rounding.

II.7.B.2. Results of Medical Cost Analysis

The per-patient lifetime direct medical costs calculated for the "average" colorectal cancer patient (as shown in Table II.7-3), diagnosed at age 70.4 are listed in Table II.7-4.

Undiscounted costs and costs discounted at three, five, and seven percent, are shown. Discounting was carried out for 14 years following diagnosis, which represents the full duration of treatment and maintenance care duration and the life expectancy at that age.

Table II.7-4. Summary of Total Costs of Medical Services (in 1996$) for Surviving Colorectal Cancer Patients

Undiscounted	Discount Rate		
	3	5	7
$141,160	$122,072	$112,026	$103,624

The costs presented in this chapter were current in the year the chapter was written. They can be updated using inflation factors accessible by clicking below.

Link to inflation factors

The actual average period of maintenance is not known and is likely to vary considerably among individuals, depending on age, health status, access to care, and other factors. For the EPA requirements under which this analysis was developed, however, this method is assumed to represent the average colorectal survivor.

II.7.B.3. Other Studies

Riley et al. (1995) studied cancer costs, but their results are not recommended due to characteristics of their study design and data quality. They studied Medicare payments from diagnosis to death in elderly cancer patients. Cost estimates presented in the paper were based only on Medicare payments, data that do not include most nursing home care, home health care, pharmaceuticals unless supplied for inpatients, out-of-pocket expenses, deductibles, charges in excess of Medicare paid by other sources (e.g., coinsurance), and other related medical services not covered by Medicare.

Medicare patients younger than 65 years old were not included, and the average age at diagnosis of the colorectal cancer cohort was 76.2 years, in contrast with the national average of 70.4. Riley et al. noted that patients diagnosed at younger ages often incurred higher costs. In addition, those

diagnosed at earlier stages had a better prognosis, but may have had higher medical costs (due to longer continuing care).

Medical costs were reported for all patients diagnosed with colorectal cancer, and did not differentiate between colorectal cancer costs and those of other diseases. Determination of colorectal medical costs were calculated by subtracting background costs. The background cost per year for medical services was estimated by Riley et al., based on the experience of all people over the age of 65 who received Medicare-compensated care. This value was estimated to be $2,250 in 1990 dollars ($3,154 in 1996 dollars, using the CPI 1990-1996 multiplier of 1.4). This estimate excluded costs that occurred during the last year of a person's life. Consequently, the estimated background value reported may underestimate background costs and this omission would lead to a slight overestimate of incremental costs.

Riley et al. estimated that the total average incremental Medicare payment from diagnosis to death for persons diagnosed with colorectal cancer was $51,865 in 1990 dollars ($72,611 in 1996 dollars). This estimate is considerably lower than the estimates obtained from Baker et al. The difference is most likely due to the exclusion of many costs that are not covered by Medicare, in addition to the various other factors described above. As a result of such limitations, the Riley et al. study is not recommended for a benefits evaluation.

II.7.C. Uncertainties and Limitations

There are many limitations in cancer cost estimation. Those common to most cancers are discussed in the introductory cancer chapter: II.1

Link to Chapter II.1

Several aspects of this analysis contain underlying uncertainties based mainly on the limited information concerning some analytical inputs. A discussion of the uncertainty and limitations regarding the data sources of the analysis (Section II.7.C.1) and the scope of the analysis (Section II.7.C.2) follows below.

II.7.C.1. Uncertainties Surrounding Key Inputs to the Analysis

II.7.C.1.1. Analysis of Medical Costs

The cost estimates based on Baker et al. (1989, 1991) have a number of limitations, many of them noted in Baker et al., 1991. Most of these limitations are related to the use of CMHSF. Medicare data have five limitations that decrease their value for calculating the average lifetime direct medical costs of treating lung cancer. First, Medicare covers

medical services for most persons age 65 and over, disabled persons entitled to Social Security cash benefits for at least 24 months, and most persons with end-stage renal disease. All patients not covered by Medicare are excluded from the database, including all non-disabled women under 65, and women over 65 using private health insurance (Baker et al., 1991).

Medicare also does not cover self-administered drugs, intermediate nursing care, long-term nursing care, and some expensive new treatments (such as bone marrow transplants). For some patients these may represent significant percentages of total treatment costs. Most direct medical costs, however, appear to be covered by the CMHSF database and are included in Baker et al.'s 1989 analysis. In addition, Baker et al. made adjustments for some cost elements not covered by Medicare (see Section II.7.B). Another drawback is that Baker et al. were not able to identify colorectal cancer patients in CMHSF whose diagnosis and first course of therapy did not involve hospitalization.

A fourth drawback is that Baker et al. (1989) provide no information concerning the duration of the maintenance period for colorectal cancer. The analysis in this chapter assumed that colorectal cancer survivors incur maintenance care costs for 13.8 years. If the average duration of maintenance care among survivors of lung cancer is shorter (or longer) than 13.8 years, the estimates of the costs incurred by survivors would be biased upward (or downward).

A fifth limitation with using Medicare data is that the data used by Baker are from the period 1974 to 1981. The age of the data causes uncertainty regarding changes in treatment methods and costs.

The reliability of the data contained in the database used by Baker et al. also varies. An independent analysis of CMHSF performed in 1977 by the Institute of Medicine of the National Academy of Sciences found that the frequency of discrepancies in principal diagnoses varied among diseases (Baker et al. 1991). It is unclear, however, whether the presence of misnamed diagnoses contained in CMHSF potentially increases or decreases the resultant cost estimates.

Overall, despite the limitations described above, Baker et al.'s analysis of the CMHSF data represents the most nationally-representative, per-patient lifetime estimate of the direct medical costs of treating colorectal cancer to date. Their cost estimates are based on sound criteria. Because some of the data limitations underestimate costs and others overestimate costs, the sum of the data limitations decreases the magnitude of error. More of the uncertainties in their analysis appear to underestimate costs, however, and poses the problem that the net result may likely be an underestimation of actual direct medical costs.

Although there are some uncertainties associated with the estimation of the survival and mortality probabilities used in the calculation of expected medical costs (discussed below), these uncertainties are likely to be relatively small. As noted in the text, NCI RSRs used to estimate survival and mortality for this analysis are based on the survival experience of a large group of colorectal cancer patients considered in relation to the survival experience of the general population. Although age-specific RSRs for each year post-diagnosis are not available, the age-specific five-year RSRs provided by NCI (1998) suggest that there is relatively little variation in RSRs across ages at diagnosis.

An additional limitation of this analysis is that medical costs incurred as a result of colorectal cancer, but not considered by Baker et al., may arise as a result of treatment. Secondary cancers and other adverse health effects may occur due to radiation, chemotherapy treatment, and other therapies. These effects may occur substantially after colorectal cancer treatment has been completed and can incur added medical costs not considered in this chapter. Data have not yet been located regarding the average duration of maintenance care. For purposes of this analysis, an approximately 14-year period of follow-up care was assumed to be reasonable, due to the severity of the disease and the consequences of colorectal surgery. This assumption may be revised in the future if data are located.

II.7.C.2. Scope of the Analysis

The analysis in this chapter was confined to direct medical costs by the patient. As noted in Chapter I.1, willingness-to-pay has many other cost elements. The analysis does not include time lost by the patient or their family and friends who provide care. Also omitted from cost of illness estimates are pain and suffering on the part of the patient or their family and friends, changes in job status among previously employed patients, training for new job skills due to physical limitations, or medical costs incurred after the ten-year maintenance period. These cost elements may also comprise a substantial portion of the total cost of colorectal cancer.

Link to Chapter I.1